CHAPTER 5

Results: Water Level Requirements of Lake Istokpoga Resources

ANALYSIS OF HISTORIC AND CURRENT HYDROLOGIC CONDITIONS

Historical Water Levels on Lake Istokpoga

Prior to 1962, high water events (above 40 feet NGVD) regularly occurred on Lake Istokpoga. From 1936 to 1962, high water events occurred 14 times (**Table 17, Figure 16**), with a return frequency of approximately once every two years. These periods of high water levels can play an important environmental role by 1) depositing organic matter within the floodplain to be oxidized and decomposed after flood waters recede, 2) inundating swampland, thereby reducing understory growth and 3) transporting viable seeds throughout the area, thereby supporting wetland reproduction and species diversity. Since construction and operation of water control structures, water levels reached 40 feet NGVD only once (briefly) between 1962 and 2002.

Table 17. Lake Istokpoga Water Level Statistics from Various Historic Periods of Record (all values are feet NGVD).

	1936–1962	1962–1989	1989–2000
Mean	38.6	38.5	38.8
Standard Deviation	1.3	0.8	0.56
Count (*n*)	9649	9862	4298
Median	38.5	38.6	39.0
Mode	38.4	39.4	39.4
Minimum	35.4	36.2	37.2
Maximum	42.9	40.1	39.9
Range	7.5	3.9	2.7

After 1962 and especially after 1989, the duration, magnitude and frequency of low water events were reduced from the historic (pre-1962) condition. In the 1936–1962 period, there occurred six natural low water events (at or below 36.5 feet NGVD), with an average duration of seven weeks and a return frequency of once every 3.4 years (**Table 18**). In the 1962–1985 period, two low water events occurred, one associated with a drawdown of the lake for construction of the S-68 in 1962. After 1985, water levels dropped below 36.5 feet NGVD only once, during a controlled vegetation enhancement project in 2001.

Table 18. Frequency and Duration of Low Water Events on Lake Istokpoga for the Period of Record 1939–2002 (the 1962 and 2001 events shown in italics were controlled drawdown events [that is, not naturally occurring]).

Year	Duration[1] (Weeks)	Years since Last Event
1939	less than 1	N/A
1945	5	6
1949	3	4
1950	6	1
1955	7	5
1956	20	1
1962 Drawdown	*18*	*N/A*
1971	6	9
2001 Drawdown	*19*	*N/A*
1939–2000 Mean	8	5
1939–2000 Median	6	5
1939–1963 Mean	9	4
1939–1963 Median	6	5

[1] Event defined as a period of continuous lake levels of 36.5 feet NGVD or less, with fewer than seven continuous days at or above 36.5 feet.

N/A = not applicable, because drawdown was not a natural event.

Extremely low water levels can play an important environmental function by permitting 1) the drying, compaction and oxidation of organic matter in the lake bed and littoral zone, 2) the germination and establishment of swamp and marsh vegetation and 3) the temporary concentration of aquatic prey into smaller areas to support wading bird and raptor foraging and the rearing of chicks. Prior to human suppression of natural fires, flatwood burns would ignite the dewatered lake bottom and consume exposed organic matter (FWC 2000). These periodic drydown episodes were a vital mechanism for maintaining a sandy lake bottom, reducing in-lake storage of nutrients and controlling growth of littoral zone vegetation communities. Extreme lake drydown played an important role in maintaining the shallow character of the lake, and in the future if no sediment removal projects are implemented, the suppression of low water levels could lead to eventual succession of the lake to a marsh (FWC 2000).

Current Regulation Schedule

Water levels in Lake Istokpoga are managed by operation of water control structures (structures S-68 and G-85) as guided by a regulation schedule adopted by the U.S. Army Corps of Engineers and the SFWMD (**Figure 11**). Benefits of the regulation schedule include 1) a reduction in the potential for flooding of lakeside homes and businesses, 2) a reduction in the number and severity of low water level events, thereby aiding navigational access important to the local economy and 3) sufficient dry season water availability for recreation, boating and fishing interests and for supplying water to downstream users. Nevertheless, without natural lake level fluctuations, the germination of aquatic plant seeds is reduced, buildup of organic sediments occurs and the formation and expansion of floating vegetation mats are promoted. The regulation schedule will be reevaluated by the LOW CERP Project as the latter examines the Lake Istokpoga basin with a view toward creating a balance among the environmental, flood control and water supply needs in the drainage basin. The LOW CERP Project will address the need for flood protection for the perimeter and upstream tributaries and for downstream areas west and east of the C-41A Canal, and it will also address water supply needs of agricultural users, including the Seminole Tribe of Florida.

MFLs are concerned with low water levels that cause *significant harm* to the resource, and *significant harm* would be unlikely to occur under the current regulation schedule, because low water events no longer occur to the degree that existed before water level stabilization. But because the regulation schedule will be reviewed by the LOW CERP Project and periodic drawdowns are being proposed to benefit the natural communities within the lake, a definition of the point of *significant harm* to the current resource caused by low water levels will be a useful tool.

IMPACTS OF LOW WATER LEVELS ON NAVIGATION AND RECREATION

In 1974, the SFWMD's Governing Board adopted a Regional Water Shortage Plan for the Lake Istokpoga–Indian Prairie Area (Part I, Chapter 40E-22, F.A.C). This Plan established a minimum permissible schedule (water level) for Lake Istokpoga of 37.0 feet NGVD, based on "…staff knowledge of recreational navigation access problems in the lake and residents' views of desirable lake stages as expressed at public meetings and in correspondence to the District..." (SFWMD 1991). Public and stakeholder comments at public meetings indicated that some problems with lake access began to appear when water levels fell below 38 feet NGVD. A review of Lake Istokpoga's hydrograph (**Figure 16**) indicates that naturally occurring low water conditions (that is, at or below 36.5 feet NGVD) happened infrequently and seldom lasted for more than two months, except during periods of drought (**Table 13**). The longest low water event in the period of record occurred during a two-year span (1955–1956) in which water levels were below 36.5 feet NGVD for a total of 27 weeks (**Table 13**). Prolonged low water levels can impact not only navigation but also the recreation-based businesses along Lake Istokpoga. Under the current regulation schedule (**Figure 11**) these effects are usually temporary and occur only when a controlled drawdown is conducted to enhance shoreline vegetation communities.

The LOW CERP Project is currently reexamining the Lake Istokpoga Regulation Schedule. To develop a navigation access performance measure, local experts were asked to provide input regarding the navigation and recreational access impairment associated with different water levels (Dr. Nellie Morales, personal communication). The findings from this effort are shown in **Table 19**.

Table 19. Proposed Lake Istokpoga Navigation Performance Measure (Source: USACE and SFWMD 2005)

Lake Stage (feet-NGVD)	Private Access Status	Public Access Status
≥ 38.0	Minimum impact	No impact.
37.5 – 37.99	Impaired access	Minimum (start) impact. At these stages, difficulties in getting boats into water and navigating the lake are observed. Hydrilla is also a factor. Boaters would have easier access at any of these stages if no hydrilla were present within the lake. Hydrilla does not impair access; it impairs navigation. This is true at any water level, but the lower the lake level, the greater is the impact hydrilla has on navigation and the more likely it is to affect navigation (shallower water means less water for hydrilla to mat-out).
37.0 – 37.49	Severely impaired	Impaired access. Problems at public boat ramps for large boats.
36.5 – 36.99	No private access	Severely impaired access. All public boat ramps will experience impaired access for pontoon boats and for all non-shallow-draft boats. There is approximately 50% more access impairment than at 37.0 feet. No access from RV parks. Fish camps still have limited access. Navigation is very limited (limit to where you can fish).
36.0 – 36.49		Limited access through fish camps. Public can access the lake through 2 of the fish camps. Pay a boat ramp fee to access the lake. Access at public ramps is limited to non-motorized/electric-motor boats (canoes, etc.), small-engine johnboats that can be manually launched (carried/pushed), and airboats.
<36.0		All public access is impaired.

HYDROLOGIC REQUIREMENTS OF NATURAL SYSTEMS

Requirements of Aquatic and Wetland Communities

Hydrologic conditions in wetland communities fringing Lake Istokpoga are directly controlled by lake levels. These wetlands provide important ecologic functions to the lake and should be protected. Benefits afforded by these wetlands include the following:

- Stabilization of lakeshore sediments and soils.
- Dampening of the effects of wind and wave energy.
- Water quality improvement through pollutant assimilation and processing and through reduction of sediment resuspension.
- Wildlife habitat.
- Aesthetic enjoyment.
- Crucial fish habitat that supports the locally important sport fishing economy.

The general types of wetlands found along Lake Istokpoga include marsh (typically located in the littoral zone), swamp, shrub wetlands and wet prairie (**Figure 18**). Littoral zone marsh is the most abundant wetland type (**Table 5**), encompassing more than 3,400 acres (1,400 hectares), and it includes both emergent and cattail-dominated wetlands. Forested wetlands (swamps) are also a dominant wetland type along Lake Istokpoga, although their extension is only about half that of littoral marsh; forested wetlands include swamps dominated by bald cypress, mixed swamp hardwoods or a mixture of both. Other wetland types of minor extent include shrub wetlands, usually containing wax myrtle or willow, and wet prairie. Typical hydroperiods for some of these wetland types are shown in **Table 20**.

Table 20. Average Inundation Depths and Hydroperiod for Select Wetland Types.

Wetland Type (Reference)	Mean Annual Low Water Depth	Hydroperiod (months)
Marsh–Shallow		
CH2M Hill 1996a,b	Subsurface	3–7
ESE 1992	Subsurface	4
Marsh		
Duever 2002	0.5–3.8 feet.*	6–10
Ewel 1990	Subsurface	6–9
CH2M Hill 1996a,b	Subsurface	6–10
Marsh–Deep		
Brown and Starnes 1983	Subsurface	12
ESE 1992	Subsurface	10
CH2M Hill 1996a,b	Subsurface	10–12
Lake Marsh		
ESE 1992 (littoral)	Subsurface	6
ESE 1992 (pelagic)	Subsurface	12
Swamp–Mixed, Shallow		
ESE 1992	Subsurface	3
Swamp–Mixed		
Brown and Starnes 1983	Subsurface	6–8
CH2M Hill 1996a,b	Subsurface	3–6
Duever 2002	0.5–3.0 feet. *	8–10
ESE 1992	Subsurface	5
Ewel 1990	Subsurface	6–9
Swamp–Mixed, Deep		
CH2M Hill 1996a,b	Subsurface	5–9
ESE 1992	Subsurface	6
Swamp–Cypress, Shallow		
CH2M Hill 1996a,b	Subsurface	3–7
Swamp–Cypress		
CH2M Hill 1996a,b	Subsurface	6–9
Duever 2002	1.3–3.8 feet.*	6–8
ESE 1992	Subsurface	7
Swamp–Lake Fringe		
Ewel 1990	Subsurface	6–9

*Minimum range indicates depth expected during a 1-in-10-year drought.

Water Level Requirements of Lake Istokpoga Wetlands

Using recent bathymetry data, surface elevation maps for the largest wetland areas around Lake Istokpoga were created (**Figures 28–30**). Examination of these maps indicates that littoral zone emergent vegetation (marsh) communities generally reside between 36.5 and 39.5 feet NGVD and that bald cypress/mixed hardwood swamp is generally found at elevations of 39.5 feet NGVD and higher. The ecotone, or transition area, between aquatic and deep marsh communities lies at approximately 36.5 feet NGVD, and between marsh and swamp it lies at approximately 39.5 feet NGVD. Some variation from these general elevations can exist, because the transition can be gradual, making it difficult at times to discern where one community definitively ends and another begins.

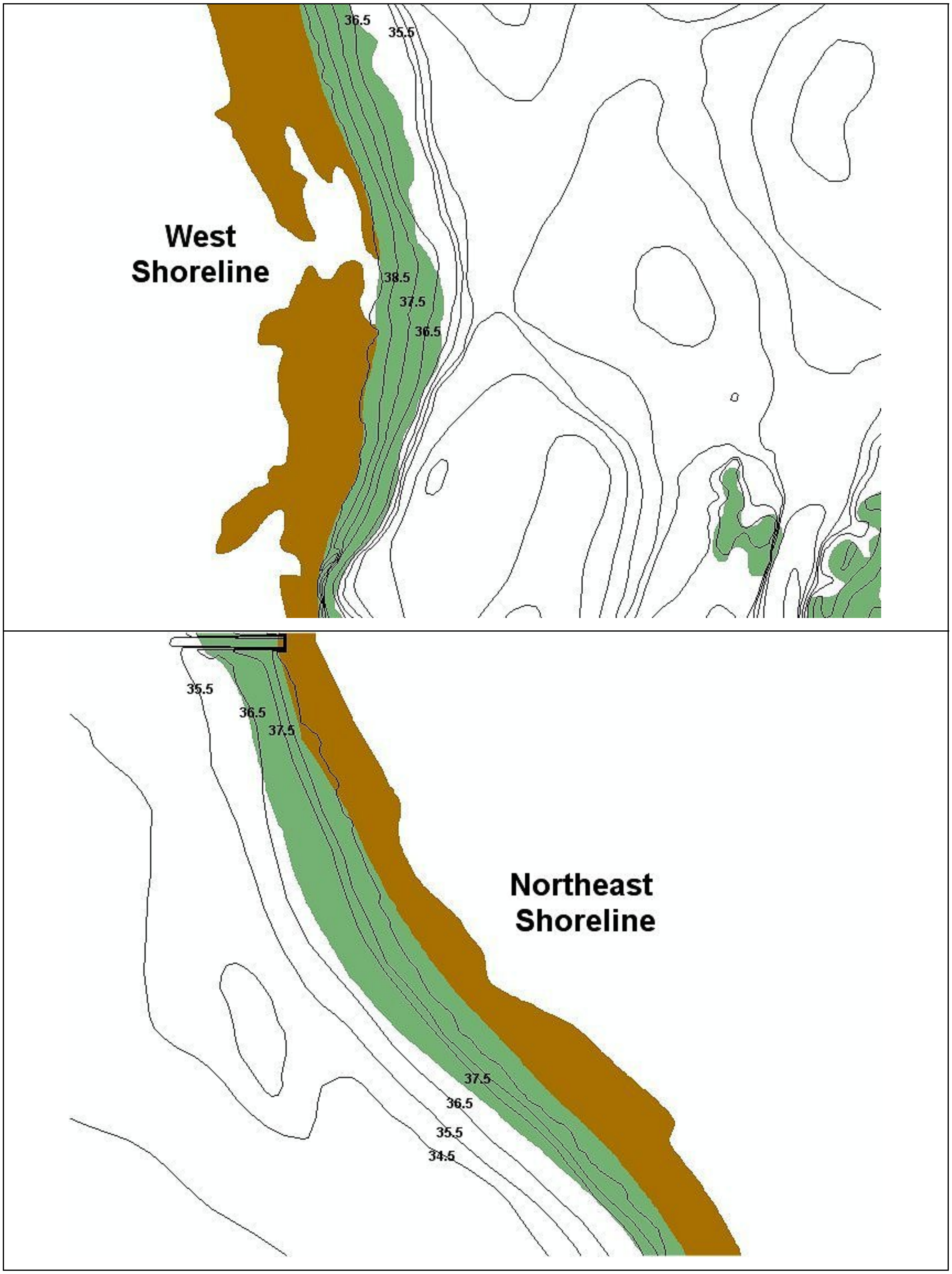

Figure 28. Elevations within Lake Istokpoga Littoral Wetlands along the West and Northeast Shorelines (green areas indicate marsh, and brown areas indicate swamp).

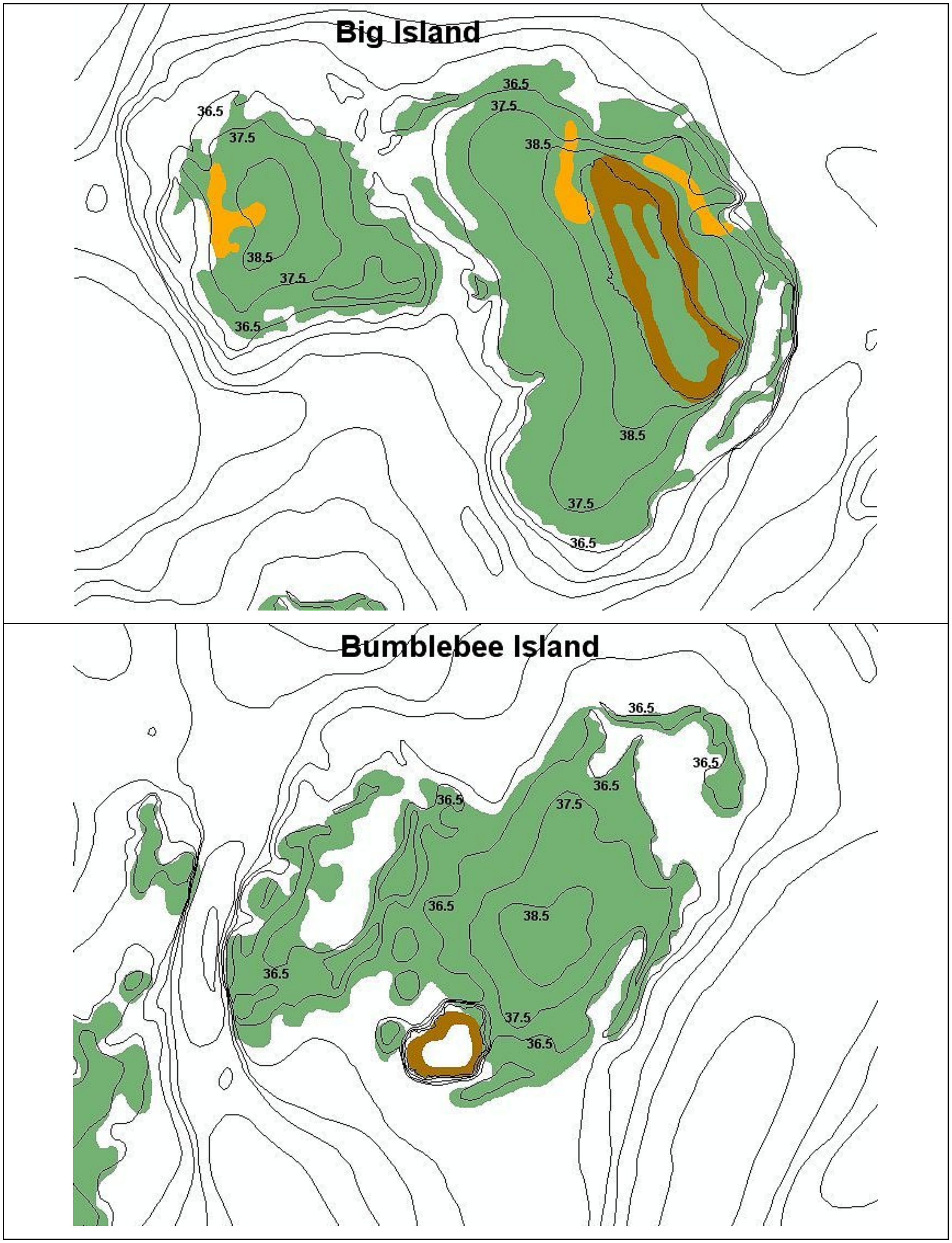

Figure 29. Elevations within Lake Istokpoga Wetlands on Big and Bumblebee Islands (green areas indicate marsh, brown areas indicate swamp and orange areas indicate shrub).

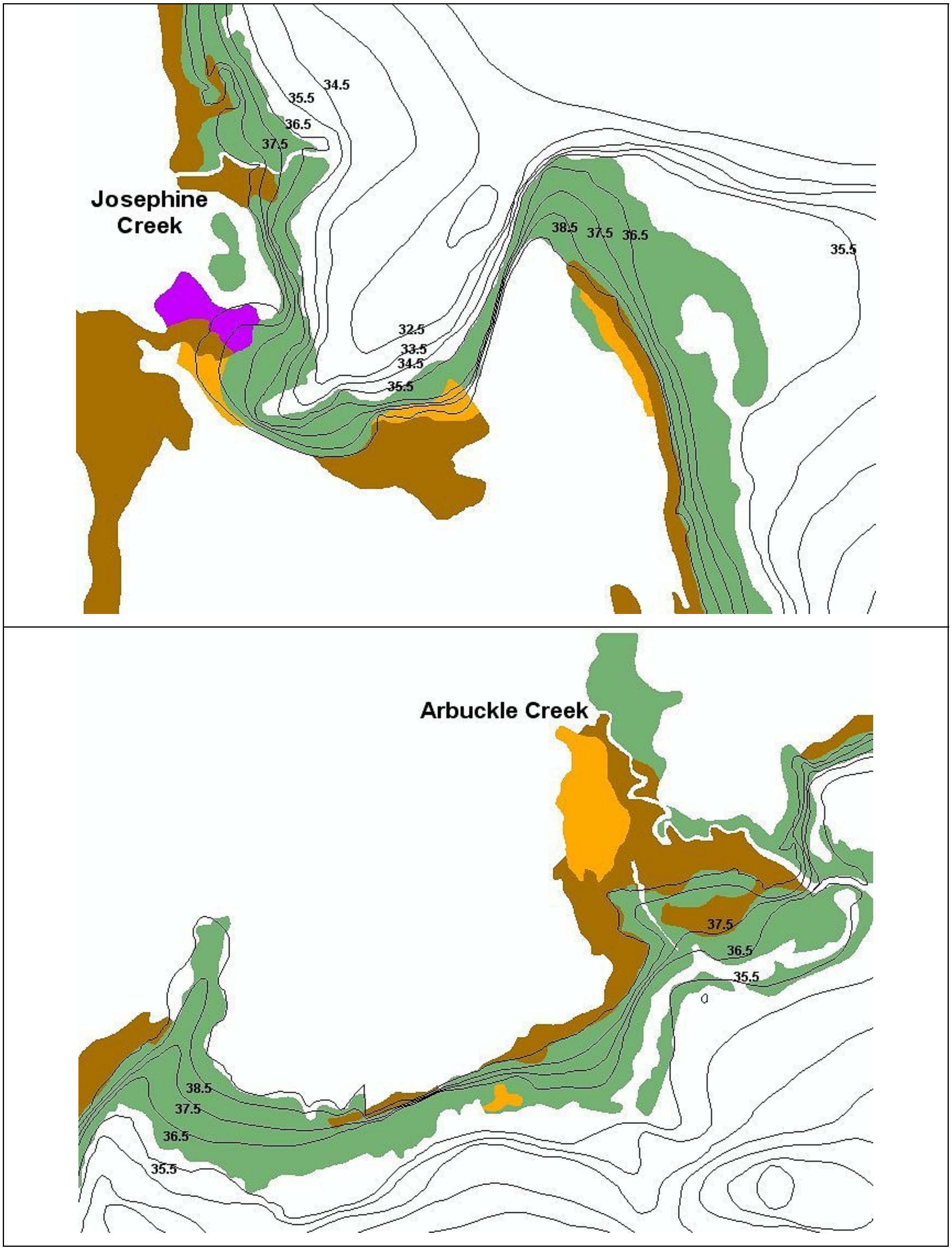

Figure 30. Elevations within Lake Istokpoga Littoral Wetlands at Josephine and Arbuckle Creeks (green areas indicate marsh, brown areas indicate swamp, orange areas indicate shrub and purple areas indicate wet prairie habitats).

The MFL criteria are concerned with protecting the existing resources of the lake and the current extent of natural communities, although the elevation and extent of natural communities may have changed since stabilization of lake levels in the early 1960s. High and low water events occurred more frequently on Lake Istokpoga before the 1960s, and so marsh and aquatic habitats may have occupied different elevations from the elevations they occupy today. Insufficient historical data exist to determine the precise historical extent of these communities. The bald cypress and mixed swamp hardwood communities contain trees of significant age and most likely persist in the same elevations they historically occupied.

The average hydroperiods of major wetland types were obtained from a review of ecologic publications (**Table 20**) and were compared with long-term lake water level data. In addition, average littoral wetland hydroperiods from the historic period (1936–1963) and from the era of the managed system (1963–2001) were compared (**Figure 31**). These results indicate that implementation of lake level management has caused hydroperiods of littoral zone marsh habitats (at current elevations) to increase and those of swamp habitats to decrease. Only infrequently has inundation of the entire fringing swamp occurred since 1963 (the commencement year of lake level regulation for flood control), as the upper level of the water level schedule is close to the ground surface elevation.

Annual average hydroperiods of bald cypress/mixed hardwood swamp are typically longer than three months, and during drought conditions water levels can fall to 3 feet below the soil surface (**Table 20**). If the average hydroperiod is reduced to below the minimum range typical for cypress swamp (that is, approximately three months), the community may come to be dominated over the years by species more characteristic of drier communities. Prolonged or frequently recurring extreme low water periods would cause excessive drying of the soil, damage to swamp vegetation and increased frequency of fire.

At 36.5 feet NGVD, the lake level is approximately 3.0 feet below the swamp's soil surface, which is the low water depth extreme (in a drought condition) reported for bald cypress (**Table 20**). Analysis of historic extreme low water events indicates that, on average, the lake fell below 36.5 feet NGVD for seven weeks once every three years (**Table 18**). During the planned 2001 drawdown, lake levels were below 36.5 feet for 19 weeks. No adverse impact to the lake's swamp community was reported during or following the drawdown event (FWC 2002).

The surface elevation of deep marsh habitat (long-hydroperiod marsh) is approximately 36.5 feet NGVD (**Figures 28–30**), corresponding to a point at which the aquatic beds become exposed. Average annual hydroperiods typical for these same deep marsh habitats are between 10 and 12 months (**Table 20**), such that this community is typically exposed only during drought periods. The drought management criterion of 37 feet NGVD in the regulation schedule (**Figure 11**) protects these wetlands from extreme drying events that may be harmful. The effect of the 2001 drawdown event on the lake's littoral marsh community was generally viewed as beneficial (FWC 2002).

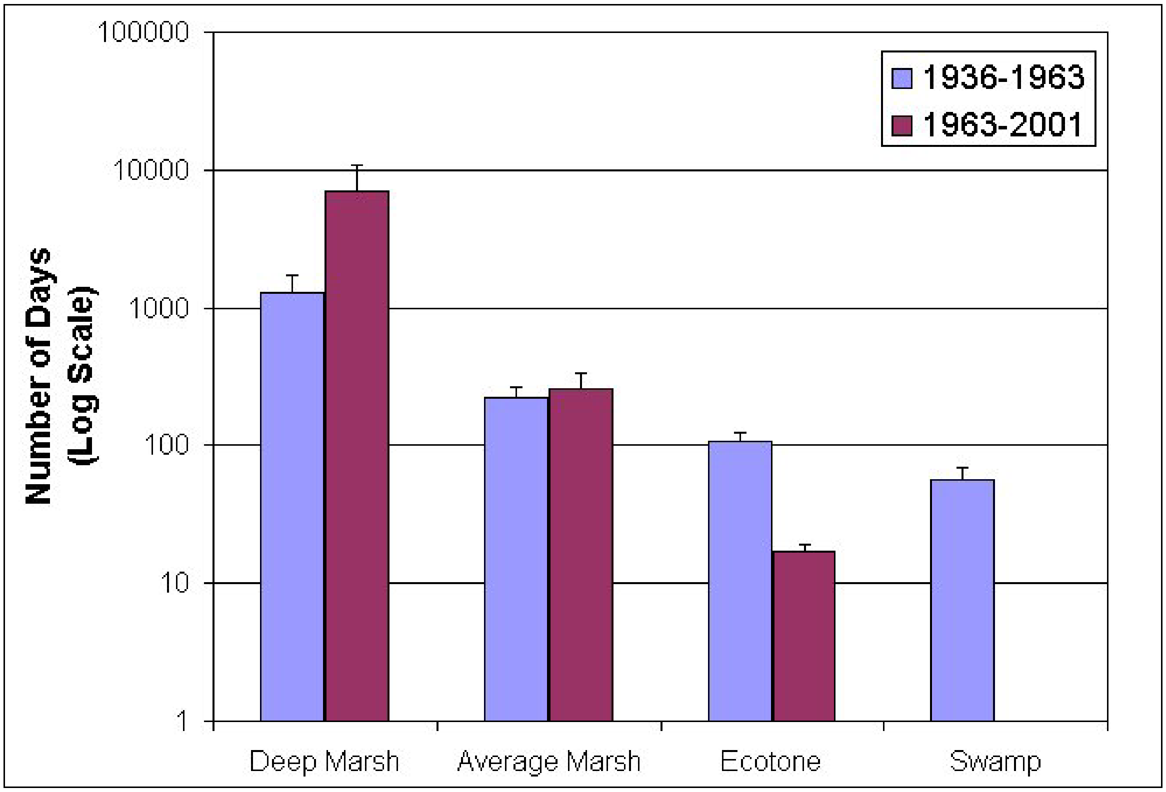

Figure 31. Average Hydroperiod in Wetlands along Lake Istokpoga (period of record excluded the 2001 controlled drawdown) (standard deviation is shown by the error bars).

Water Level Requirements of Fish Communities

The opportunity to study impacts to fish communities as a result of extreme low water events has been rare in Lake Istokpoga because water levels have been managed since the early 1960s so as to hold them within a narrow range of fluctuation. As part of the 2001 drawdown on Lake Istokpoga, lake levels were at or below 36.5 feet NGVD for 19 weeks to allow enhancement of fish habitats, to implement chemical and mechanical control of non-native and invasive vegetation and to remove muck from the lake bed. But because any one of these activities alone can influence the strength of a year-class of fish and because all the activities were conducted simultaneously, the ability to relate a change in the lake's fish populations definitively with a low water event remains problematic.

Research on impacts to fish populations from extreme low water events has been conducted in Florida lakes (for example, Moyer *et al.* 1995, Allen *et al.* 2003, Bonvechio and Allen 2005), in Florida wetlands (for instance, Chick *et al.* 2004, Trexler *et al.* 2004) and in Florida rivers (for instance, Bonvechio and Allen 2005). The existence of significant hydrogeologic differences among some of these water bodies precludes direct comparisons with Lake Istokpoga; nevertheless, these studies can offer some insight into the difficulties of trying to relate fish population changes definitively with low water events.

In 1987 a drawdown of Lake Tohopekaliga was conducted to restore 11.8 miles (19 km) of degraded littoral zone wetlands by mechanically removing approximately 215,812 yards^3 (165,000 m^3) of accumulated organic sediments. Moyer *et al.* (1995) conducted fish sampling in restored and nonrestored (control) sites in the two years following the drawdown to study potential short-term impact to fisheries. Electrofishing data from 1988 and 1989 indicated that median catch per effort for largemouth bass, redear sunfish and forage fish was significantly greater in restored sites than in control sites. Median catch-per-effort values in restored sites also were higher for bluegill, but the differences were statistically significant only in 1988. Sampling in shallow areas with Wegener rings found that age-0 largemouth bass and other sport fish were more abundant in restored areas than in control sites; nonetheless, sport fish reproduction was reduced in restored sites during 1989 and was not detected in control sites. The overall conclusion was that in general, there occurred an immediate positive fishery response to the Lake Tohopekaliga extreme drawdown and removal of organic sediments to restore littoral zone wetlands.

Largemouth bass abundance and angler catch rates were studied following the 1995–1996 habitat enhancement project on Lake Kissimmee (Allen *et al.* 2003). Lake Kissimmee is comparable to Lake Istokpoga in terms of its relatively large size (35,000 acres or 14,143 ha), tropic status, fish populations, vegetation and general management concerns. The goal of the habitat enhancement project was to improve sport fish populations, particularly of largemouth bass, and to remove dense inshore vegetation caused by water level stabilization. Water levels were lowered between November 1995 and March 1996, and the lake was refilled in June. Heavy equipment was used to remove muck from about half of the approximately 50-mile (80-km) shoreline. Recolonization of scraped sites occurred throughout the 1997–2000 period. Improved growth and abundance of age-1 largemouth bass were detected for at least two of the year-classes (the 1997 and 1998 classes) after the habitat enhancement project, but no increase in harvestable largemouth bass abundance or in angler catch rates was demonstrated (Allen *et al.* 2003).

The benefits of a managed drawdown for the purposes of habitat enhancement are multifaceted. Muck removal restores lost fish habitat, opens up littoral areas for fishing and boating activity, improves access to the lake by homeowners and fish camps, increases dissolved-oxygen concentrations in littoral habitats and expands fish diversity in enhanced sites (Allen and Tugend 2002, Tugend and Allen 2004). Minns *et al.* (1996) argued that freshwater habitat enhancement efforts should focus on general ecosystem and multispecies benefits rather than on promotion of a single preferred species. In any case, the responses of different sport fish populations to drawdown and muck removal will probably vary, and the effects on adult fish abundance and angler catch rates may be difficult to detect (Allen *et al.* 2003).

As just noted, a low water event seldom occurs alone without other factors (such as habitat enhancement efforts), and the ability to relate a low water event directly to a negative impact to fisheries is not clear-cut. Furthermore, data from sampling conducted in newly restored habitat is not comparable with pre-drawdown data collected from other areas of the lake. This having been said, however, available fish sampling data are unable to indicate *significant harm* to Lake Istokpoga's fish resource as a result of the drawdown. In other words, comparison of fish sampling data from before and after the drawdown is unable to indicate that any multiyear negative impact to the fishery occurred (see **Figure 25, Table 13).** Data collected after the drawdown indicated a healthy fishery two years after the drawdown event (**Figures 20, 21** and **Tables 11, 12, 14, 15)**.

In fact, because of the restoration and expansion of littoral zone fish habitats, a long-term benefit to the fishery is expected, as was found on Lake Tohopekaliga and Lake Kissimmee following drawdowns. More indirectly, management and protection of the lake's wetland and aquatic plant communities constitute prerequisites for healthy fisheries. The magnitude and duration of the 2001 drawdown event were comparable to those of naturally occurring low water events that took place before management of lake levels (see **Figure 16** and **Table 18**). In this regard, it must be borne in mind that long-lasting low water events have not occurred in close succession historically and that such a scenario should continue to be avoided in order to prevent multiyear negative impacts to year-classes of fish. Excessive prolongation of water levels, or stages, at less than 36.5 feet NGVD may be harmful to fish communities, since littoral zone habitats—important foraging and spawning areas for fish—are dry at this water level. Severe or frequent low water conditions that cause a change from littoral marsh to a more upland community type could reduce the extent or quality of fish habitats and thereby cause declines in fish foraging and spawning success.

Water Level Requirements of Bird Communities

Lake Istokpoga contains three types of habitats important for bird species—aquatic, littoral marsh, and swamp (**Table 21, Figure 18**). Most bird species require more than one habitat type in order to feed, nest and rear chicks to adulthood successfully (Ehrlich *et al.* 1988, Bird 1999). Ospreys, for instance, nest in the swamp adjacent to the lake and feed from the lake's aquatic habitat (Stewart 2001). Of the 26 known species of birds associated with Lake Istokpoga habitats, 21 use more than one habitat type (**Appendix E**).

Table 21. Highlands County Bird Species Associated with Lake Istokpoga Habitats.

Species (Common Name)	Nesting Season[1]	Nesting Habitat[1]	Feeding Habitat[1]
American Kestrel	March through June	Swamp trees (cavity nest)	Littoral, swamp
Bald Eagle	September through May	Swamp trees (high nest)	Aquatic[2], littoral, swamp
Barred Owl	December through April	Swamp trees (cavity nest)	Littoral, swamp
Black-Necked Stilt	April through June	Littoral vegetation	Aquatic, littoral
Common Moorhen	March through September	Littoral vegetation	Aquatic, littoral
Cooper's Hawk	April through July	Swamp trees	Littoral[3], swamp[3]
Fulvous Whistling Duck	March through August	Littoral vegetation	Aquatic, littoral
Great Blue Heron	Extended through the year	Swamp trees	Aquatic, littoral, swamp
Great Egret	Year-round	Swamp trees	Aquatic, littoral, swamp
Green Heron	March through July	Swamp trees or shrubs	Aquatic, littoral, swamp
Limpkin	February through June	Littoral vegetation	Littoral
Mallard		Littoral vegetation	Aquatic, littoral
Mottled Duck	February through September	Littoral vegetation	Aquatic, littoral
Northern Harrier	February through September*	----------------------------	Aquatic, littoral, swamp
Osprey	Year-round	Swamp trees (high nest)	Aquatic, swamp
Pied-Billed Grebe	Year-round	Littoral vegetation	Aquatic
Purple Gallinule	March through September	Littoral vegetation	Aquatic, littoral
Red-Shouldered Hawk	January through May	Swamp trees	Littoral, swamp
Red-Tailed Hawk	January through June	Swamp trees (mature)	Littoral, swamp
Red-Winged Blackbird	March through July	Littoral vegetation	Littoral
Sandhill Crane	December through June	Littoral (often nests in wet areas)	Littoral
Short-Tailed Hawk	February through May	Swamp trees	Littoral[2], swamp[2]
Snail Kite (Everglades Snail Kite)	Year-round	Swamp or littoral vegetation	Littoral
Swallow-Tailed Kite	April	Swamp trees (tall cypress)	Littoral, swamp
Tricolor Heron	February through August	Swamp trees or shrubs	Aquatic, littoral
Wood Duck	January through June	Swamp trees (cavity nest)	Aquatic, littoral

[1]Source: National Geographic Soc. 1987, Ehrlich *et al*. 1988, Poole *et al*. 1992, Bird 1999.

[2]indicates special cases having very long hydroperiods, such as aquatic beds and aquatic mud flats that may occasionally be exposed during drought conditions.

[3]indicates an indirect association.

The primary habitat types used by birds in the Lake Istokpoga area are as follows:

- Aquatic habitats—open-water areas possibly containing submerged vegetation. Many types of fish are found in the water column, and numerous species of invertebrates and other animals live within the vegetation beds.
- Littoral marsh (nonforested wetlands)—found on the broad flats that surround the lake. Marsh vegetation provides shelter and nourishment for a variety of organisms important as food sources for some bird species. In addition, tall wetland plants provide nesting sites and cover for certain birds.
- Swamps (forested wetlands)—found mostly along the southern area of the lake. These areas are located behind the littoral zone, and these forests are important roosting and nesting sites for wading birds and many raptors.

To protect the critical habitats required by many bird species found along Lake Istokpoga, the aquatic, marsh and swamp habitats must be protected from significant changes (that is, from a shift to drier community types, with an associated change or loss of function), which are assumed to equate to *significant harm*. It is assumed that MFL criteria, which protect these natural systems, will also protect the bird communities from *significant harm*.

Data are lacking that might relate the effects of low water events directly to changes in bird populations within Lake Istokpoga, but studies from other areas of Florida can provide some insight into potential impacts. Generally, low water levels in wetland-lake systems are associated with improved feeding and successful rearing of chicks since low water levels concentrate the birds' aquatic prey into smaller areas (Kushlan 1976, 1986, 1989; Ogden *et al.* 1976). The maintenance of higher water levels tends to reduce foraging success. On the other hand, the drying of wetlands (which causes mortality of prey) can be negative; if reduced water levels persist and affect prey habitat or lead to reduction of prey populations, an indirect impact to bird communities may result.

SUMMARY OF ANALYSIS

Two distinct periods are discernible from the water level time series data for Lake Istokpoga. During the historical, or pre-management, period (1936–1962), Lake Istokpoga fell below 36.5 feet NGVD for seven weeks once every 3.4 years, on average (**Table 18**). Since the initiation of the lake management period, the lake has fallen below 36.5 feet NGVD only three times, two of which were associated with controlled drawdowns to build a water control structure (1962–1963) and to undertake an environmental enhancement project (2001).

The need to protect developed lands along Lake Istokpoga from flooding prohibits reflooding of some remnant swamp areas, particularly of those that are situated above 39.5 feet NGVD (the upper range of the regulation schedule—see **Figure 11**). It is recognized that wetland communities require a minimum period of flooding and that alteration and development of lake shore areas constitute a constraint on management of some natural areas along Lake Istokpoga. It is also recognized that an appropriate depth of flooding is required to maintain the swamp's health; that parameter, however, is beyond the scope of the MFL project.

The minimum water level threshold proposed for Lake Istokpoga is 36.5 feet NGVD. This elevation is derived from the water level identified as the point at which surface water is absent in most littoral wetlands along the lake (**Figures 28–30**) and at which access to the lake for navigational and recreational purposes is impaired (**Table 19**). Adverse impacts to fish and bird communities are not expected from periodic, short-duration low water events at (or below) 36.5 feet NGVD, but prolonged events may be undesirable. Management of low water events based on these resource functions is in harmony with the considerations set forth in the MFL rule. Impacts to water supply are considered to be minimal, since the current regulation schedule stops water releases from Lake Istokpoga when water levels fall below the minimum operating level (Zone B), which ranges from 39.0 feet at the end of the wet season to 37.5 feet at the end of the dry season (**Figure 6, Figure 11**).